CLAIMS OF THE INVENTION

I CLAIM:

1. A method for generating a point of laser-induced damage in a material by controlling breakdown process development of damage areas comprising:

generating laser radiation having sufficient energy to induce a plasma condition at a point in said material; and

directing said laser radiation at said point to generate said plasma condition and thereafter maintain said condition until sufficient total energy has been delivered to said material so that a resultant damage area of the desired size will be created in said material.

2. The method in accordance with Claim 1 wherein said laser radiation comprises a single pulse of laser energy, said energy exceeding an energy threshold for effecting a breakdown of the material by a negligible amount and wherein the size of the area of damage is controlled by changing the time of the pulse duration.

3. The method in accordance with Claim 1 wherein said laser radiation comprises a laser pulse with a specific form so that said plasma condition is generated at the beginning of the pulse and is thereafter only maintained.

4. The method in accordance with Claim 1 including the step of controlling a life of said plasma condition with said laser radiation to generate an area of damage having a desired brightness and size.

5. The method in accordance with Claim 1 including generating said plasma condition with at least a first energy packet of laser radiation and thereafter maintaining said plasma condition with one or more second energy packets of laser radiation.

6. The method in accordance with Claim 1 including the steps of applying a first portion of laser radiation to generate said plasma condition and applying at least one second portion of laser radiation to maintain said plasma condition, and waiting a period of time between said application of said first portion of laser energy and said at least one second portion of laser energy, said period of time comprising a time sufficient for the shocked stress induced by the first portion of energy to substantially dissipate.

7. The method in accordance with Claim 1 including the steps of applying a first portion of laser radiation to generate said plasma condition and applying at least one second portion of laser radiation to maintain said plasma condition, and including the steps of determining a number of said second energy portions needed for creation of a point of laser induced damage having a desired brightness, determining an energy level for said second portions to support said plasma condition, and determining a period of time between said pulses during of which a substantial portion of the morphological dynamics of damage creation induced by the application of a previous portion of laser energy has occurred.

8. A method for generating an area of laser-induced damage in a material by controlling a spacial structure of a laser radiation directed at a material comprising:

generating laser radiation having a spacial structure of a laser radiation with sufficient energy to induce a plasma condition at an area in said material; and

directing said laser radiation at said material to induce laser damage by dispersal of laser energy at an area so that a density of said laser energy exceeds a threshold energy density for effecting breakdown of said material by a negligible amount and such that a size of said area is larger than a normal focal spot but smaller than the size of the desired damage area.

9. The method in accordance with Claim 8 including generating a laser radiation having a spacial structure such that each area of damage comprises several separate locations where an energy applied by said laser radiation exceeds an energy threshold necessary to effect a breakdown of said material, and wherein a distance between adjacent locations is approximately equal to a threshold distance for breakage of said material.

10. The method in accordance with Claim 8 including generating a laser radiation having a transverse mode TEMmn of the radiation and directing said radiation at said area.

11. The method in accordance with Claim 8 including the step of determining values for integers m and n of the right transverse mode of said laser beam so that energy peaks associated with said radiation when applied to said area cover a focal area and a distance between adjacent peaks is approximately equal to a distance threshold.

12. The method in accordance with Claim 8 including the step of controlling the values of m and n of the transverse mode TEM_{mn} to control the brightness and shade of the resulting area of damage.

13. The method in accordance with Claim 8 wherein $m < m_0$ and $n < n_0$, where m_0 and n_0 are such that the focused energy is inside the desired resulting damage area.

14. An apparatus for producing high quality laser-induced images inside optically transparent materials by controlling breakdown process development and space structure of laser radiation comprising:

main laser beam having a main energy level which exceeds an energy threshold for causing a breakdown of the material;

a divider for dividing said main laser beam into two separate second and fourth laser beams, said second beam having an energy level sufficiently high to cause damage in said material, said fourth beam having an energy level sufficiently high to support a plasma condition;

means for directing said second beam into an optical system which forms a pattern of a laser output at a focus point inside said material;

at least one time delay mechanism;

means for directing said fourth beam to said at least one time delay mechanism and then to said optical system for directing at said same focus point inside said material at a time later than said second beam.

15. The apparatus in accordance with Claim 14 further including:

a divider for dividing said second laser beam before said second laser beam is directed to said optical system, said second laser beam divided into two separate third and fifth laser beams, said third beam having an energy level sufficiently high to cause damage in said material, said fifth beam having an energy level sufficiently high to support a plasma condition;

means for directing said third beam into said optical system which forms a pattern of a laser output in a focus point inside an article;

means for directing said fourth beam to said time-delay mechanism;

a divider for dividing said fourth beam into two separate sixth and seventh laser beams, each of said sixth and seventh beams having an energy level sufficiently high to support a plasma condition in said material;

means for directing said sixth beam into an optical system which forms a pattern of a laser output in a focus point inside said material;

means for directing said fifth beam to said time-delay mechanism;

means for dividing said fifth beam into two separate eighth and ninth laser beams, each of said eighth and ninth laser beams having an energy level sufficiently high to support a plasma condition in said material;

a divider for dividing the said eighth beam into two separate eleventh and twelfth beams, each of said eleventh and twelfth laser beams having an energy level sufficiently high to support a plasma condition in said material; and

means for directing said twelfth beam into an optical system which forms a pattern of a laser output in a focus point inside an article.

16. The apparatus in accordance with Claim 14 including means for controlling the number of laser beams interacting with the material.

17. The apparatus in accordance with Claim 14 wherein said time delay mechanism is arranged to delay one or more of said laser beams so that their interaction with said material occurs after a substantial portion of the morphological dynamics of a damage creation induced by a previous laser pulse has occurred.

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